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TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO. (If known see 37 C.F.R. 1 5) 09/937457

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/EP00/02041	09 MARCH 2000	29 MARCH 1999

TITLE OF INVENTION **DRYING DEVICE AND PROCESS FOR ITS PRODUCTION**

APPLICANT(S) FOR DO/EO/US **Franz-Josef BECKER, Robert-Peter KLEIN**

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to promptly begin national examination procedures (35 U.S.C. 371(f)).
4. ☒ The US has been elected by the expiration of 19 months from the priority date (PCT Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☒ have not been made and will not be made.
8. ☐ A English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☐ A FIRST preliminary amendment.
14. ☐ A SECOND or SUBSEQUENT preliminary amendment.
15. ☐ A substitute specification.
16. ☐ A change of power of attorney and/or address letter.
17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 – 1.825.
18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. ☒ Other items or information:

    PCT/RO/101, PCT/ISA/210, PCT/IPEA/416, 409
    1 sheet of drawings

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"Express Mail Post Office to Addressee" Service under 37 CFR 1.10 on the date indicated above and is addressed to the Assistant Commissioner for Patents and Trademarks, Box PCT Washington, DC 20231

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U.S. APPLICATION NO. (If known, see 37 C.F.R. 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NO.
09/937457	PCT/EP00/02041	512100-2020

21. ☒ The following fees are submitted

	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(5): Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO $1000.00	
International preliminary examination fee (37 C.F.R. 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO $860.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO $710.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4 ..... $690.00	
International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) $100.00	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 860.00
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total Claims	25 - 20 =	5	x $18.00	$ 90.00
Independent Claims	5 - 3 =	2	x $80.00	$ 160.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ $270.00	$

TOTAL OF ABOVE CALCULATIONS =	$
☐ Applicant claims small entity status. See 37 C.F.R. 1.27. The fees indicated above are reduced by ½. +	$
SUBTOTAL =	$
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(f)).	$
TOTAL NATIONAL FEE =	$ 1,110.00
Fee for recording the enclosed assignments (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +	$ 40.00
TOTAL FEES ENCLOSED =	$ 1,150.00
Amount to be refunded:	$
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a. ☒ Two checks in the amount of **$ 1,150.00** to cover the above fees are enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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Dated: September 24, 2001

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28,029
REGISTRATION NUMBER

Drying device and process for its production.

Description

The invention is directed to a device capable of reducing the moisture content, and/or ensuring a defined moisture content, in a closed gas space surrounding said device, to a process for producing such a device, and to the use of said device.

Such drying devices are known in the prior art. They can comprise desiccant-filled containers which are used, for example, for dry storage of moisture-sensitive products.

A desiccant pouch is known which is available commercially under the name Desimax™ from the company Multiform Desiccant Inc. (Buffalo, New York). This type of desiccant pouch consists of two pouch walls which enclose an interior space by means of weld seams at the edge of the pouch walls. Said interior space contains a defined amount of desiccant, namely 4 Å molecular sieve. The pouch walls themselves are at least partly permeable to water vapor.

The disadvantage of such a system is that the defined, limited amount of desiccant present in the pouch interior space corresponds to only a defined, limited moisture absorption capacity. If the amount of desiccant is exhausted by attainment of the maximum absorption capacity for moisture (i.e., essentially water), the desiccant pouch remains ineffective. Further absorption of moisture/water is impossible, and nor is it possible to ensure a constant atmospheric humidity, in particular a reduced atmospheric humidity, in a closed gas space surrounding said desiccant pouch.

In the processing of such desiccant pouches, therefore, the problem occurs that prolonged contact (for example, several minutes) with the ambient air, which generally contains more than 40% relative atmospheric humidity, must be avoided, since otherwise rapid exhaustion occurs, so rendering the desiccant pouch unusable for its subsequent utility in, for example, the production of packaging for moisture-sensitive products. A solution to this problem is either to carry out processing in rooms with constant, greatly reduced relative atmospheric humidity which are closed to the outside, or

to accelerate the processing steps which are performed during contact with the ambient air.

In addition, desiccant pouches are not very multifaceted in terms of their usefulness for different drying needs, since the amount of desiccant per pouch (and thus the maximum moisture/water absorption capacity) is limited by the internal volume.

A further disadvantage of desiccant-filled pouches is that the desiccant is present within such a pouch in a solid, usually granulated or powdered form. At the filling stage, therefore, there is first of all a need for very precise metering of the desiccant during the production process. However, when such a system comes under relatively severe mechanical stress, there is a risk that the pouch wall or the weld seam at the edge of the pouch will tear open and that the desiccant will exit. Where the desiccant is not harmless, or may enter into chemical reactions with the product that is to be stored under reduced and/or defined moisture content conditions in a surrounding, closed gas space, therefore, a desiccant pouch of this kind also constitutes a certain safety risk for said product.

DE 196 46 048 discloses packaging for transdermal therapeutic systems, having internally fixed drying devices. This desiccant-containing packaging comprises multilayer laminates. With the aid of a pressure-sensitively adhesive layer, a desiccant layer present therein can be fastened to the assembly comprising the other layers of the laminate. Like the desiccant pouch already described, this packaging is also subject to the rapid exhaustion of the moisture/water absorption capacity in the case of prolonged contact with normal ambient air. By normal ambient air is meant air which does not have a reduced relative atmospheric humidity but instead has at least 40% relative atmospheric humidity. Consequently, processing of these packaging laminates likewise requires process steps within a room closed off with respect to the environment, and/or working in a room with reduced reduced atmospheric humidity.

It is an object of the present invention to provide a device for reducing the moisture content of a closed gas space surrounding said device, or for establishing a defined relative atmospheric humidity, which avoids these

disadvantages of the drying devices known in the prior art. The intention is in particular to avoid the need for processing and/or storage beforehand in a closed gas space of reduced moisture content surrounding the device, and/or processing under conditions which are extremely limited in terms of time.

This object is achieved by means of a drying device which comprises a matrix with a desiccant present in it and which can be activated under industrially relevant conditions. If desired, the drying device may include a water-vapor-permeable layer. The matrix can, if desired, be lined directly with this layer. The desiccant comprises a regenerable desiccant. The drying device of the invention and, in particular, the desiccant matrix are preferably in sheet form. In one particular embodiment, the desiccant matrix of said drying device is or has a pressure-sensitively adhesive layer.

For the purposes of the invention, the matrix is a carrier for the desiccant. Suitable materials for said matrix are in principle organic and inorganic materials, especially polymeric materials. The matrix materials must possess the capacity to admit the penetration of water molecules into the material and the migration of these molecules within the material. On the other hand, this incoming water must not result in complete dissolution of the polymeric material. Examples of suitable materials are polymeric substances such as acrylates, silicones, polyisobutylenes, SIS rubber, SBS rubber, SEBS rubber, polyvinylpyrrolidone, polyurethane, polyesters, polyethylene, polyvinyl alcohol, polyamides, ethylene-vinyl acetate, polyacrylic acid, Kollidon (copolymer of vinyl acetate and vinylpyrrolidone), and cellulose derivatives. In principle, any film-forming materials can be used. It is of course also possible to use mixtures of the organic polymer materials mentioned. The matrix is free from pharmaceutical active substances.

The matrix is preferably in sheet form. This means that in the spatial conformation of this matrix the three dimensions (height, length and width) are in defined proportions with respect to one another. The height of the sheet-form matrix has a minimum value of about 50 µm and a maximum value of about 3 mm; the height of the sheet-form matrix is preferably between 200 and 500 µm.

The width and length of the sheet-form matrix are not critical parameters, but can be adapted to the practical requirements in each case. Approximately 2 mm can be regarded as a minimum value of the width for practical handleability of the sheet-form matrix. The width of the sheet-form matrix is preferably between about 1 and about 50 cm, with particular preference between about 2 and about 10 cm.

Like the width, the length of the sheet-form matrix can likewise in theory be infinite. For the reason of more simple handleability, preferred lengths are likewise between about 1 and about 50 cm, with particular preference between about 2 and about 10 cm.

In one preferred embodiment the desiccant matrix is elastic, by which is understood the capacity for the matrix to exhibit a reversible change of shape. This results in an improvement in certain properties of the matrix, for example, the softness, the pliability, the flexibility and the machineability. For this purpose it is necessary to add substances to the matrix that are able to influence said properties. Such substances include plasticizers (elasticizers) for the respective matrix materials. Examples of suitable plasticizers are polyethylene glycol, polypropylene glycol, glycerol, Miglyol, propanediol, triglycerides, esters such as diethyl phthalate, tributyl citrate, etc., which are added to the matrix if desired in amounts such that the desired elasticity is obtained. This is of course dependent in particular on the nature of the respective matrix material and on the nature of the respective plasticizer, although the other constituents of the desiccant matrix may also have certain influences on the elasticity, so that it is not possible to specify exact limits for the quantitative proportions. Preferably, however, quantitative proportions of from about 1 to 40% plasticizer are present in the matrix (based on the overall weight of the matrix).

In another embodiment the desiccant matrix can be pressure-sensitively adhesive, by which is meant the ability for the matrix, once pressed onto a surface with a certain pressure, to be permanently bonded to said surface. For this purpose it may be necessary to add substances to the matrix which influence this property. Such substances include tackifiers (tackifier resins). Appropriate tackifiers are known to the skillled worker: examples

are rosin esters and hydrogenated esters of rosin, hydrocarbon resins, etc., which are added, if desired, to the matrix in amounts such that the desired pressure-sensitive adhesive property is obtained. When choosing the amount of tackifier it is necessary to take account of the specific matrix materials. Here again, the other constituents of the desiccant matrix may have influences on the pressure-sensitive adhesion property, and so it is not possible to specify exact limits for the quantitative proportions. The ranges of amounts are therefore in general between about 5 and 70% tackifier in the matrix. Preferably, quantitative proportions of from about 10 to 30% tackifier are present in the matrix (based on the overall weight of the matrix).

In the embodiment in which the drying device comprises a pressure-sensitively adhesive layer, or, even, where the desiccant matrix itself is pressure-sensitively adhesive, said drying device judiciously includes an abhesive backing layer (release liner) which covers this pressure-sensitively adhesive layer and from which the drying device is peeled off prior to its use. The materials for such backing layers are known to the skilled worker and can, for example, comprise films containing substances such as polyethylene terephthalate, polyethylene, polypropylene, paper, and modifications thereof.

As already mentioned, the drying device may further comprise a water-vapor-permeable layer. If desired, the matrix can be lined with this layer. The water-vapor-permeable layer can be present on one or both sides of the sheet-form matrix. Appropriate materials for a water-vapor-permeable protective layer of this kind are, for example, cellulose in the form of film, nonwoven, paper, perforated film, etc.

In a further embodiment, the drying device may also include a support layer. The purpose of this layer is to give the drying device greater dimensional stability. This may be the case, for example, when the desiccant matrix itself, owing to very low thickness or relatively high elasticity, is too flexible for practical handleability. The support layer can, if desired, line the matrix or may even be identical with the water-vapor-permeable layer. The support layer can be on one or both sides of the sheet-form matrix. Appropriate materials for such a support layer are

materials known to the skilled worker, such as PET film, polyethylene, polypropylene, paper, nonwovens, etc.

If desired, the drying device may also include a protective layer which is intended to protect the desiccant matrix against external mechanical stress, e.g., abrasion, or against the exit of desiccant. If desired, this layer can be identical with the water-vapor-permeable layer and/or with the support layer. Appropriate materials for the protective layer are materials known to the skilled worker, e.g., polymers such as polyethylene, polypropylene, paper, nonwovens, etc.

It is possible for the drying device to include a layer which fulfills at least two of the technical functions of water-vapor-permeable layer, support layer, and protective layer.

If desired, the desiccant matrix may also include a moisture indicator whose color depends on the water content and which thus indicates whether the desiccant present in the matrix is still capable of further absorption of water. Examples of suitable moisture indicators of this type are copper(II) salts or cobalt(II) salts such as $CuSO_4$ or $CoCl_2$, for example.

For the purposes of the invention, a desiccant is a substance which is able to absorb moisture, but especially water. The ability of such substances to absorb moisture may be based on a chemical or physical effect. Regenerable desiccants – i.e., substances capable under certain conditions of releasing absorbed moisture (for example water) again and thereby undergoing transition to a state in which the substance is capable of renewed moisture absorption – are particularly suitable for the invention. Appropriate regenerable desiccants are $CaSO_4$ (calcium sulfate, anhydrous gypsum, anhydrite), $CaSO_4 \cdot \frac{1}{2}H_2O$ (hemihydrate), $CaCl_2$, Al_2O_3, CaO, Na_2SO_4, K_2CO_3, $CuSO_4$, $Mg(ClO_4)_2$, $MgSO_4$, silica gel (blue indicator gel), polyvinylpyrrolidone (PVP), and mixtures of at least two of these substances.

In accordance with the invention, these substances are used as solids or as a solution. The physical form is not particularly important: it may comprise crystals, powders, amorphous solids, granules, triturated forms,

etc. However, the size of these desiccant solids is limited by the requirements for the thickness of the sheet-form matrix. An upper limit for the size of the solid particles is therefore about 200 µm; however, preference is given to the use of particles having a grain size below 50 µm. The minimum grain size of these particles is 1 µm.

The amount of desiccant in the matrix depends primarily on the desired moisture/water absorption capacity of the drying device in question and on the moisture/water absorption capacity of the particular desiccant used.

If, for example, only a low water absorption capacity is required, the use of a desiccant of low water absorption capacity in a small amount in the desiccant matrix may be sufficient. A small amount of desiccant (in active form) close to the lower limit, in the matrix might represent, for example, from about 0.5 to 5% of the overall weight of the desiccant matrix. In that case, the thickness and surface area of the desiccant matrix may even be situated at the respective lower limits.

Where the required water absorption capacity of the drying device is very high, however, it is necessary to use a desiccant matrix containing a relatively large amount of desiccant, the desiccant as well being required to possess a high water absorption capacity. A large amount of desiccant (in active form) of this kind may represent, for example, from about 50 to 70% of the overall weight of the desiccant matrix.

The drying device as such is activatable. This means that the article in its entirety, but of course in particular the desiccant matrix, is stable with respect to the conditions under which the desiccant present in the matrix is regenerated. There must be no irreversible decomposition of individual components or permanent deformation owing, for example, to instances of material softening. This is ensured by using materials which possess resistance to increased temperatures, thermal radiation, or microwaves.

The actual activation of the drying device, or of the desiccant matrix, can be done by various means. The most simple type of activation is to store the desiccant matrix under increased temperature (for example, at 105, 110, 120, 140 or 170°C) for a defined period. The higher the chosen

temperature, the shorter the required storage period. Other possibilities for activation can consist in the use of infrared radiation or microwave irradiation.

As additional measures, a reduced external pressure (for example 0.2 atm) and/or an artificially generated air circulation may facilitate the chosen activating conditions (for example, temperature, duration, radiation intensity). The application of these additional measures may also mean that in the case of increased-temperature activation this temperature need not be above 100°C, the boiling point of water under standard conditions, but may even be from about 60 to 80°C.

As a result of activation, the regenerable desiccant undergoes transition to its active form, in which it possesses the capacity to absorb moisture/water.

It is clear that when choosing the activation method, which may also consist in a combination of different activation methods and additional measures, it is necessary to take account of the materials present in each case in the drying device and/or in the desiccant matrix and of the properties of said materials (sensitivity to infrared or microwave radiation and/or increased temperatures). Otherwise, it may be necessary to adapt the materials of the desiccant matrix and/or of the drying device to the required activating conditions. In addition, it may be necessary to adapt the economy of the activation method to the material costs of the drying device.

Specific embodiments of a desiccant matrix are sheet-form systems, by which are meant, for example, labels, films, tapes, rolls, stickers, or disks.

The advantages of the drying device of the invention are, inter alia, that the desired moisture/water absorption capacity of the drying device can be adapted to the particular need by means of simple calculation of its surface area and, if appropriate, of its thickness and of the concentration of the desiccant in the matrix. This is based on the fact that the water absorption capacity of the drying device, at constant thickness and constant concentration of desiccant in the matrix, is generally in a linear correlation with its surface area. If the water absorption capacity of a drying device

used is exhausted, a greater drying requirement might be able to be supplemented by simply adding an additional, readily calculable surface area to the drying device of the invention.

The drying device of the invention is used to reduce the moisture content of a closed gas space surrounding said device or to maintain a defined, preferably a reduced, moisture content in a closed gas space surrounding said device. It can therefore be utilized in a method of reducing the moisture content of a closed gas space surrounding said device or of maintaining a defined, preferably a reduced, moisture content in a closed gas space surrounding said device.

Said gas space must be gastightly closed so that there can be no exchange with ambient air and the atmospheric humidity from the surroundings which it contains. Closed gas spaces of this kind may be, for example, airtight packaging of products.

The possibilities for application of the drying device of the invention are therefore located within the field of the packaging of moisture-sensitive articles, such as, for example, foods, drugs, diagnostic agents, medicaments, moisture-sensitive chemicals, and biologically activatable material. Preference is given to the use of drying devices of the invention within packaging for tablets, transdermal therapeutic systems, and sheet-form pharmaceutical administration forms for oral use.

Where the desiccant present in the matrix possesses the ability to bind molecules of substances other than water (i.e., for example, organic solvents such as ethanol, methanol, etc., odorous substances such as acetaldehyde, acetic acid, etc., gaseous substances such as CS_2, NH_3, H_2S etc.), a target utility can consist in reducing the amount of such molecules in the gas space surrounding the drying device and/or in keeping said gas space substantially free from such molecules.

The production and performance of the drying device of the invention will be elucidated on the basis of the following examples.

Example 1

347.84 g of 2-propanol are mixed with
46.36 g of polyethylene glycol 400 and
81.4 g of Kollidon 90 and the mixture is homogenized with stirring. Subsequently
127.5 g of calcium sulfate x $2H_2O$ are introduced and the mixture is homogenized at high stirring speed.

The resultant, solvented desiccant composition is coated onto a 23 μ polyester film so as to give, following evaporation of the solvent, a desiccant layer of 200 g/m². The open side of the desiccant layer is laminated with a 26 g/m² paper. Punched specimens measuring 10 cm² are produced and are activated at 100°C for 5 hours.

Example 2

347.84 g of 2-propanol are mixed with
46.36 g of polyethylene glycol 400 and
81.4 g of Kollidon 90 and the mixture is homogenized.
127.5 g of calcium sulfate x $2H_2O$ are introduced into the homogeneous solution, and the mixture is homogenized at high stirring speed.

The resultant, solvented desiccant composition is coated onto a 23 μ polyester film so as to give, following evaporation of the solvent, a desiccant layer of 200 g/m². In a separate coating operation, the commercial pressure-sensitive adhesive Durotak 387-2287 (manufacturer: National Starch & Chemical) is coated onto a single-sidedly abhesive polyester film so as to give, following evaporation of the solvent, a pressure-sensitive adhesive coat of 20 g/m². The open side of the pressure-sensitive adhesive coat is laminated with the polyester side of the desiccant coat. Punched specimens measuring 10 cm² are produced and are activated at 105°C for 5 hours.

Example 3

Five each of the punched specimens produced by the processes described in Example 1 and in Example 2 are subjected to a test to determine the water absorption capacity. For this purpose, following initial activation in a desiccator, the punched specimens were stored over supersaturated calcium nitrate solution (≙ 55% relative humidity) for at least 24 hours. The water absorption which has taken place is determined by weighing the punched specimens at defined intervals of time.

After 24 hours, there was a slow decrease in the water absorption capacity of these specific drying devices. The punched specimens were reactivated under the conditions specified in Example 1 and, respectively, in Example 2 and were subjected to a second test to determine the water absorption capacity.

Table 1 shows the results of these experiments on the water absorption of the drying devices of the invention. It can be ascertained that the water absorption takes place continuously over a period of at least 24 hours.

Table 1:

	Water absorption (mg) $\bar{X}$ n=5 after storage				
	1 hour	2 hours	4 hours	6 hours	24 hours
Example 1	6.90	10.10	12.22	13.72	17.64
Example 2	4.74	7.28	9.38	11.38	15.52

	Water absorption after reactivation (mg) $\bar{X}$ n=5 after storage				
	1 hour	2 hours	4 hours	6 hours	24 hours
Example 1	7.30	8.78	10.28	10.98	14.78
Example 2	6.62	8.28	10.30	11.14	15.18

The drying capacity of the drying device of the invention is therefore not restricted (as in the case of the prior art drying devices) to one-off and/or short-duration drying.

The experiment of Example 3 also shows, however, that the drying device of the invention can be used to perform a method of reducing the moisture content of a closed gas space and/or maintaining a reduced moisture content of a closed gas space, which comprises in a first step converting an activatable drying device, comprising a sheet-form matrix having at least one regenerable desiccant, by activation into the active state, in a further step placing the activatable drying device in the active state into the gas space whose moisture content is to be reduced and/or whose reduced moisture content is to be maintained, in a further step airtightly closing said gas space with respect to the surroundings; finally, in a further step, the activatable drying device in the active state absorbs moisture from the airtightly closed gas space over a prolonged period of, for example, at least one hour.

Figure 1 shows different embodiments of the activatable drying device of the invention. The different elements are explained in the attached legend. The figure depicts:

1 = activatable drying device consisting of a desiccant matrix.

2 = activatable drying device consisting of a desiccant matrix and a support layer.

3 = activatable drying device consisting of a release liner, a fixing means, a support layer, and a desiccant matrix.

4 = activatable drying device consisting of a release liner, a desiccant matrix, and an underlying support layer.

5 = activatable drying device consisting of a desiccant matrix surrounded by two support layers.

6 = activatable drying device consisting of the assembly of release liner, a fixing means, and a desiccant matrix surrounded by two support layers.

What is claimed is:

1. An activatable drying device which comprises a sheet-form matrix having at least one regenerable desiccant present therein.
2. The drying device as claimed in claim 1, which further comprises a layer of a water-vapor-permeable material.
3. The drying device as claimed in claim 1, which further comprises a pressure-sensitively adhesive layer.
4. The drying device as claimed in claim 1, which further comprises a protective layer.
5. The drying device as claimed in claim 1, which further comprises a support layer.
6. The drying device as claimed in claim 1, which further comprises a backing layer (release liner).
7. The drying device as claimed in claim 1, wherein the desiccant matrix is elastic.
8. The drying device as claimed in claim 1, wherein the desiccant matrix is pressure-sensitively adhesive.
9. The drying device as claimed in claim 1, wherein said regenerable desiccant is selected from the group consisting of $CaCl_2$, $CaSO_4$, Al_2O_3, Na_2SO_4 and polyvinylpyrrolidone.
10. The drying device as claimed in claim 1, wherein said sheet-form matrix comprises a polymeric material.
11. The drying device as claimed in claim 1, wherein said regenerable desiccant is present in an amount of between 0.5 and 70% in said sheet-form matrix (based on the overall weight of the matrix).
12. The drying device as claimed in claim 1, wherein the sheet-form matrix present therein has a height of between about 50 µm and 3 mm.
13. A process for producing a sheet-form drying device, which comprises:
    a) preparing a desiccant matrix comprising a regenerable desiccant in nonactive form, with no additional measures to reduce the moisture content of the ambient air space,
    b) if desired, performing further steps for producing a sheet-form drying device comprising said desiccant matrix, these steps likewise being performed without additional measures to reduce the moisture content of the ambient air space, and

c) subsequently activating the sheet-form drying device.

14. The process as claimed in claim 13, wherein said activating takes place by storing the sheet-form drying device at increased temperature.

15. The process as claimed in claim 13, wherein said activating takes place by irradiating the sheet-form drying device with infrared light.

16. The process as claimed in claim 13, wherein said activating takes place by irradiating the sheet-form drying device with microwaves.

17. The process as claimed in claim 13, wherein said activating is assisted by additional air circulation.

18. The process as claimed in claim 13, wherein said activating is further assisted by a reduced external pressure.

19. The process as claimed in claim 13, wherein said activating takes place by a combination of storage at increased temperature and/or irradiation with infrared light and/or irradiation with microwaves, with or without the use of additional measures comprising additional air circulation and/or reduced external pressure.

20. The use of a sheet-form, activatable drying device for reducing or maintaining constant a defined moisture content of a closed gas space surrounding said device.

21. The use as claimed in claim 20, wherein said gas space surrounding said device further comprises a moisture-sensitive article.

22. The use as claimed in claim 20, wherein the moisture-sensitive article is a food, a drug, a diagnostic agent, a medicament, a chemical, or a biologically activatable material.

23. The use as claimed in claim 20, wherein the moisture-sensitive article is a tablet, a transdermal therapeutic system, or a sheet-form pharmaceutical administration form for oral use.

24. The use of a sheet-form drying device for removing molecules of organic solvents and/or odorous substances from a gas space surrounding said device.

25. A method of reducing the moisture content of a closed gas space and/or maintaining a reduced moisture content of a closed gas space, which comprises

a) in a first step converting an activatable drying device, comprising a sheet-form matrix having at least one regenerable desiccant, by activation into the active state,

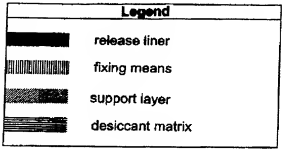
b) in a further step placing the activatable drying device in the active state into the gas space whose moisture content is to be reduced and/or whose reduced moisture content is to be maintained,

c) in a further step airtightly closing said gas space with respect to the surroundings; and

d) in a further step, the activatable drying device in the active state absorbs moisture from the airtightly closed gas space over a period of at least one hour.

Fig. 1:


1
2
3
4
5
6


Legend
release liner
fixing means
support layer
desiccant matrix

COMBINED DECLARATION FOR PATENT APPLICATION AND POWER OF ATTORNEY

As below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

Drying device and process for its production

the specification of which
- is attached hereto
- was filed on

and including all the amendments through the date hereof.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, § 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application (s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application (s) for which Priority is Claimed:

1.) Federal Republic of Germany, 19913761.7 of March 26, 1999

And I hereby appoint
William F. Lawrence, Registration No. 28,029, of the firm FROMMER LAWRENCE & HAUG, LLP whose post office address is 745 Fifth Avenue, New York, New York 10151, or their duly appointed associate, my attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to file continuation and divisional application thereof, to receive the Patent, and to transact all business in the Patent and Trademark Office and in the Courts in connection therewith, and specify that all communications about the application are to be directed to the following correspondence address:

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New York, New York 10151

Direct all telephone calls to:
(212) 588-0800, to the attention
of : William F. Lawrence

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Signature: _____ Date: 18.07.01

Signature: _____ Date: 20.07.01

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